

**Space Weather Technical Forecast**

Issued on Monday 7 October 2024 at 13:30 Local

**This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>**

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**Space Weather Forecast Headline: G1/Minor Geomagnetic Storms likely day 1 and 2 (07-08 Oct) given CME influence. Isolated R1/R2 Radio blackouts expected on all days.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity is Moderate, with a peak M1.5 flare observed at 06/2119 UTC from AR3842.

There are ten sunspot groups on the Earth-facing disc, two of which have been recently numbered. The southwest quadrant remains heavily populated with large, complex regions, namely AR3842 and AR3844. AR3842 continues to show some decay in its intermediate spots, but continues to display a significant delta configuration. AR3844 is becoming difficult to analyse as it approaches the limb. AR3841 in the northwest continues to decay, becoming mostly plage. AR3848 appears to be largely stable. AR3849 has been split into two regions, with AR3850 located to the south and west. A new region AR3852 emerging on the east limb, analyse remains difficult due to foreshortening and classification subject to change.

There is a large filament in the southwest of the disc that, given its location, is a feature worth monitoring for any possible lift-off and subsequent CME, should it destabilise.

No significant Earth-directed CMEs were observed in the past 24 hours.

**Solar Wind / Geomagnetic Activity:** The solar wind varied between Slightly Elevated and Elevated speeds for much of the period, 430-520km/s, following recent CME arrival. Despite this, the solar wind density remained at Below Average levels throughout. The Interplanetary Magnetic Field (IMF) fluctuated around the Moderate threshold, but was enhanced to Moderate to Strong levels following passage of the CME front (peak 17nT at 06/1414 UTC). The north-south component was initially Weak, but strengthened to become Moderate to briefly Strong after the CME arrival, ranging between +17/-13nT, with periods moderately negative. The phi angle varying between negative and positive (away from the Sun) after the arrival of the CME.

The net result of the above solar wind measures was generally Quiet to Active (Kp2-2) conditions, but with G1 Minor Geomagnetic storm (Kp5) intervals.

**Energetic Particles / Solar Radiation:** High energy (greater than 10 MeV) proton flux observed by GOES18 was at Background levels.

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High energy electron flux (greater than 2MeV) observed by GOES16 was at Normal Background to Moderate levels (at diurnal peak). The associated 24-hour fluence was below the Active threshold, roughly level with 5.84e6 observed at 06/2359UTC.

## Four-Day Space Weather Forecast Summary

**Solar Activity:** Solar activity is expected to remain generally Moderate, with a slight chance of increasing to High levels given the risk of isolated X-class flares, mainly from AR3842 and AR3844.

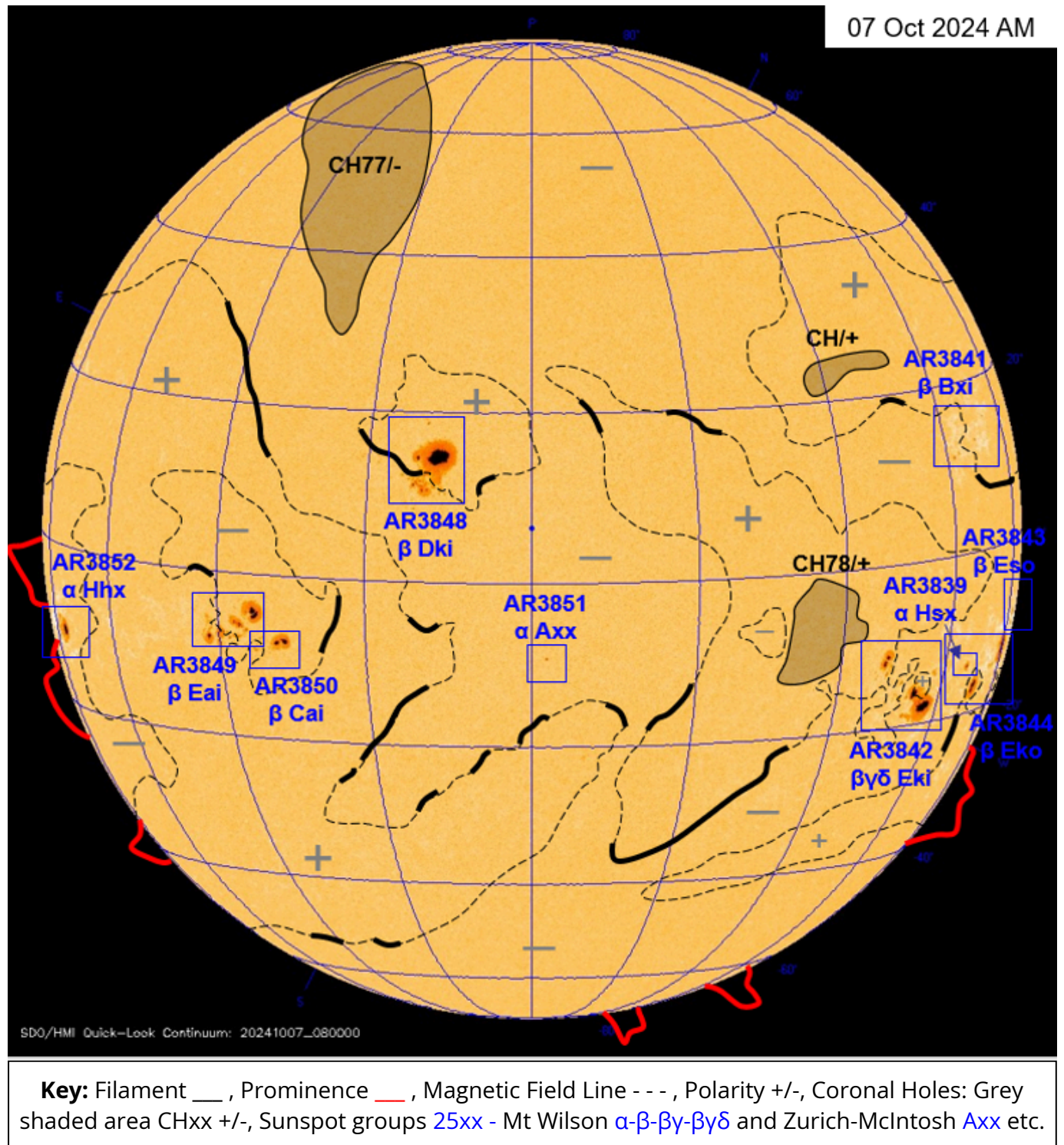
**Solar Wind / Geomagnetic Activity:** There is a chance of a glancing impact late on Day 1 (07 Oct) or early Day 2 (08 Oct) from a CME that left the southwest quadrant of the Sun on 04 Oct.

Geomagnetic activity is likely to be mostly Unsettled to Active, but with isolated G1/Minor Storm intervals likely through the remainder of Day 1 (07 Oct) and into Day 2 (08 Oct) given continued CME influence and potential coronal hole enhancement. Becoming mostly Quiet to Unsettled by Days 3 and 4 (09-10 Oct).

**Energetic Particles / Solar Radiation:** High energy proton flux at GOES18 is forecast to persist at Background, with a daily chance of exceeding the S1/Minor Storm threshold should further significant flares occur.

High energy electron flux at GOES16 is expected to be at Background to Moderate levels through much of, if not the entire forecast period. There is a chance of daily High flux being reached as CME and coronal hole enhancements subside on Day 3 (09 Oct). 24-hour integrated fluence is expected to remain well below the Active (1e8 integrated flux) threshold. Any lasting recovery will probably not come until later in the coming UTC week.

Figure 1: Synoptic map valid 07/0800 UTC



## Geomagnetic Storms

A CME was detected at ACE at 06/0655 UTC, likely the delayed arrival of the CME resulting from the X9.0 flare of AR3842 on 03 Oct. So far the response in solar wind parameters has been fairly modest, but is likely to increase once Earth passes through the magnetic cloud of the CME.

One potential further CME arrival features in the forecast period. The M4.0 flare of AR3842 on 04 Oct resulted in a CME evident in LASCO and STEREO A imagery, but appears to overlap with pre-existing ejecta from two filament eruptions in the southwest disc from a similar period, reducing confidence in the analysis of the feature. A glancing impact is possible according to MOSWOC ENLIL later on Day 1 (07 Oct) or early Day 2 (08 Oct) but with the bulk of the ejecta expected to pass below and ahead of Earth.

Current wind speeds are somewhat erratic at Slightly Elevated levels (450-500 km/s) as the recent CME subsides. Values may be continue to be enhanced overnight and into Day 2 (08 Oct) given the potential for the CME mentioned above, as well as an influence possible from small equatorial CH78/+, in the western disc, which may become geoeffective later on Day 1 or early Day 2 (07 or 08 Oct), though may be indistinguishable from enhancements caused by the ongoing CME influence. Speeds for the high speed stream alone are thought unlikely to exceed 500km/s however. A slow decline in winds speeds is expected during Day 3 and 4 (09-10 Oct) with conditions currently expected to decline towards background.

Geomagnetic activity is likely to be mostly Unsettled to Active, but with isolated G1/Minor Storm intervals likely through the remainder of Day 1 (07 Oct) and into Day 2 (08 Oct) given continued CME influence and potential coronal hole enhancement. Becoming mostly Quiet to Unsettled by Days 3 and 4 (09-10 Oct).

| Geomagnetic Storm           | Level    | Past 24 Hours<br>(Yes/No) | Day 1<br>(00-24 UTC) | Day 2<br>(00-24 UTC) | Day 3<br>(00-24 UTC) | Day 4<br>(00-24 UTC) |
|-----------------------------|----------|---------------------------|----------------------|----------------------|----------------------|----------------------|
| Probability<br>(Exceedance) |          |                           | (%)                  | (%)                  | (%)                  | (%)                  |
| Minor or Moderate           | G1 to G2 | Yes                       | 70                   | 60                   | 5                    | 1                    |
| Strong                      | G3       | No                        | 5                    | 1                    | 1                    | 1                    |
| Severe                      | G4       | No                        | 1                    | 1                    | 1                    | 1                    |
| Extreme                     | G5       | No                        | 1                    | 1                    | 1                    | 1                    |

Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time<br>21.5R☉<br>(UTC) | Halo: Full<br>or<br>Partial | Source                | Source<br>Location | Estimated<br>Speed<br>(km/s) | Estimated<br>Arrival<br>Time (UTC) | Comments                                                                  |
|------------------------------|-----------------------------|-----------------------|--------------------|------------------------------|------------------------------------|---------------------------------------------------------------------------|
| 04/1040                      | Partial                     | AR3842 +<br>Filaments | SW                 | 585                          | 07/1800 UTC                        | Moderate<br>confidence<br>in arrival.<br>Low<br>confidence<br>in timings. |

## Radio Blackouts - X-Ray Flares

The southwest quadrant remains heavily populated with large, complex regions, namely AR3842 and AR3844. AR3842 has seen some minor decay in its intermediate spots, otherwise there is little change to the group. Both regions still harbor a very slight potential for X-class flares given their historical activity.

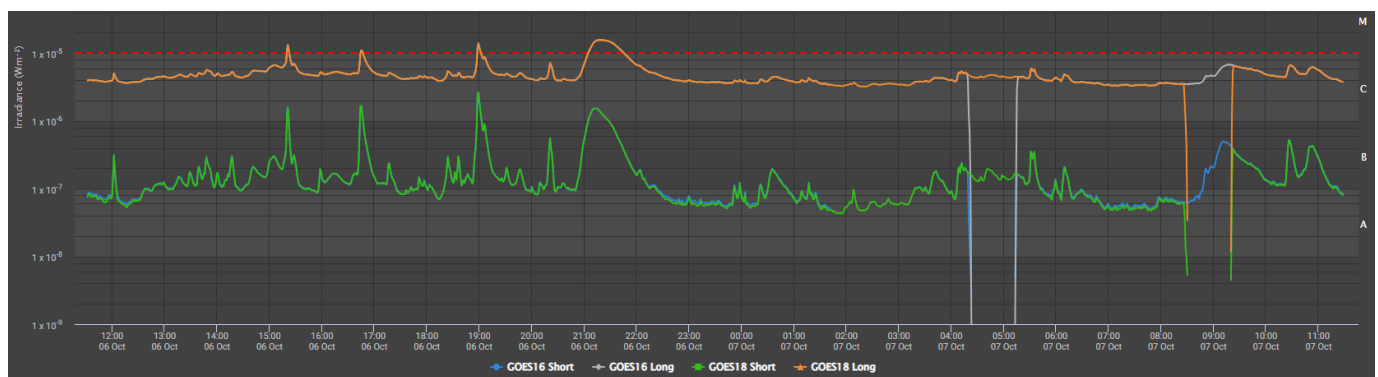
Meanwhile, in the eastern disc, AR3848 appears to be largely stable, although has seen some minor growth in its northern periphery, with limited flare activity. A new region appears to be emerging on the east limb, although its currently difficult to analyse due to foreshortening.

Far side helio-seismographs and returning Carrington's due in the period suggest that there are no significant inbound complex regions in the coming four days. The main consideration for X-ray flare risk is therefore any simplification (or intensification) of the current active regions, as well as the gradual depopulation of the southwestern quadrant. AR3843 and AR3844 should rotate off in turn towards UTC midweek, and there is a resultant slight decrease in the probabilities of significant flares. Even with these departures, the risk of flares remains high due to the continuing presence of AR3842 and the larger regions in the eastern hemisphere.

Solar activity is Expected to be generally Moderate, with a slight chance of increasing to High levels given the risk for isolated X-class flares. The risk of Strong flares comes mainly from AR3842 and AR3844, with this risk easing slowly into the period.

| X-Ray Flares | Level              | Past 24 Hours<br>(Yes/No) | Day 1<br>(00-24 UTC) | Day 2<br>(00-24 UTC) | Day 3<br>(00-24 UTC) | Day 4<br>(00-24 UTC) |
|--------------|--------------------|---------------------------|----------------------|----------------------|----------------------|----------------------|
| Probability  |                    |                           | (%)                  | (%)                  | (%)                  | (%)                  |
| Active       | R1-R2<br>(M Class) | Yes                       | 80                   | 80                   | 70                   | 60                   |
| Very Active  | R3-R5<br>(X Class) | No                        | 20                   | 20                   | 15                   | 10                   |

**Figure 2: Latest 24hr GOES16/18 X-Ray Flux**



**Solar Radiation Storms (High Energy Protons)**

High energy proton flux at GOES18 has thus far failed to respond to any of the recent significant flares, however this becomes more likely as sunspots' advance towards the western horizon. There remains a daily chance of S1+ enhancement, mainly from AR3842 and AR3844. The risk of S1 moderating slightly as AR3843 and AR3844 increasingly rotate off the Earth-facing side towards UTC midweek.

| Radiation Storms                                                                                                                                                   | Level<br>( $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$ ) | Past 24 Hours<br>(Yes/No) | Day 1<br>(00-24 UTC) | Day 2<br>(00-24 UTC) | Day 3<br>(00-24 UTC) | Day 4<br>(00-24 UTC) |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|---------------------------|----------------------|----------------------|----------------------|----------------------|
| Probability<br>(Exceedance)                                                                                                                                        |                                                          |                           | (%)                  | (%)                  | (%)                  | (%)                  |
| Active                                                                                                                                                             | $\geq \text{S1}$                                         | No                        | 30                   | 30                   | 20                   | 15                   |
| Very Active                                                                                                                                                        | $\geq \text{S3}^*$                                       | No                        | 5                    | 5                    | 5                    | 1                    |
| * $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and/or $50 \text{ MeV} \geq 10 \text{ pfu}$ . ( $\text{pfu} = \text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$ ) |                                                          |                           |                      |                      |                      |                      |

High Energy Electrons ( $\geq 2\text{MeV}$ )

High energy electron flux (greater than 2MeV) observed by GOES16 was at Normal Background to briefly Moderate levels. Ongoing CME and potential coronal hole influence is likely to cause flux at GEO to remain subdued in the coming days, and the extent of any recovery on Days 3 and 4 (09-10 Oct) is low confidence. Some periods of diurnal High flux are possible on Days 3-4 (09-10 Oct) as solar wind pressure eases, but more likely later in the coming week, outside of the current forecast period.

24-hour integrated fluence is expected to remain well below the Active ( $1\text{e}8$  integrated flux) threshold. Any lasting increase not likely until later in the coming UTC week.

MOSWOC REFM output is low confidence given the ongoing influence of CMEs in the forecast.

| GEO Electron Environment    | Level<br>( $\text{cm}^{-2}\text{sr}^{-1}\text{day}^{-1}$ ) | Past 24 Hours<br>(Yes/No) | Day 1<br>(00-24 UTC) | Day 2<br>(00-24 UTC) | Day 3<br>(00-24 UTC) | Day 4<br>(00-24 UTC) |
|-----------------------------|------------------------------------------------------------|---------------------------|----------------------|----------------------|----------------------|----------------------|
| Probability<br>(Exceedance) |                                                            |                           | (%)                  | (%)                  | (%)                  | (%)                  |
| Active                      | $\geq 2\text{ MeV}$<br>$\geq 1\times10^8$                  | No                        | 1                    | 1                    | 5                    | 10                   |
| Very Active                 | $\geq 2\text{ MeV}$<br>$\geq 1\times10^9$                  | No                        | 1                    | 1                    | 1                    | 1                    |

Figure 3: Latest MOSWOC REFM model output

